

APPENDIX F

CANOPY DENSITY ASSESSMENT FOR THE ST. REGIS RIVER TMDL

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Introduction

Factors influencing stream temperature include solar radiation, the density of riparian vegetation, channel morphology, discharge, and stream aspect. Shade provided by riparian vegetation decreases the amount of solar radiation reaching the channel. A decrease in the canopy density along the stream channel can increase the amount of solar radiation reaching the stream channel, which leads to increased water temperatures (Hostetler 1991). An examination of stream temperature within the Lochsa River of Idaho found that a reduction in average canopy density and tree height in riparian stands as a result of human disturbance led to increased water temperatures (HDR 2002).

Methods

The magnitude and location of canopy density along the St. Regis River was assessed using the 2000 aerial photographs (1:15,840 scale) and a mirror stereoscope. Ten reaches previously delineated along the St. Regis River using the 1996 orthophoto quads were divided into 70 subreaches based on channel aspect, land ownership, and changes in valley type. Reaches 1 through 9 were divided into subreaches varying in length from 700 to 8,500 feet. Average reach length was approximately 3,000 feet. Aerial coverage allowed for 5,300 feet to be measured within Reach 10. Overall, canopy density was assessed along 202,000 feet (96%) of the St. Regis River, as well as the lower portions of nine tributaries.

Stereo aerial photography was used to assess several parameters using the 2000 aerial photographs. For each subreach the stationing, length, aspect, canopy density along the left and right banks, bankfull channel width, distance from Interstate 90, the percent of the reach containing at least 100 feet of riparian buffer, land ownership, and valley type were recorded. Subreach stationing and length were measured progressing upstream using the 1996 orthophoto quads with 500-foot increment mid-channel stationing. Left and right banks were analyzed individually assuming a downstream perspective. Channel aspect was measured on the 1996 orthophoto quads by placing a compass at the lower end of a subreach and recording the angle upstream. Channel aspect categories were defined as 0 (north/south), +45 (northeast/southwest), 90 (east/west), and -45 (northwest/southeast).

Canopy density, which influences the amount of streamside shading and the amount of solar radiation reaching the stream, was determined separately for both the left and right banks within each subreach. Canopy density was measured in 5% increments using a crown density/percent crown cover scale while viewing paired images from the year 2000 under a mirror stereoscope. The use of paired images created a 3-dimensional perspective upon which canopy density was measured. The mean canopy density for each subreach was visually determined for each bank individually. Canopy densities along the left and right banks were then averaged to give an

overall subreach canopy density. Canopy density was also assessed along the privately owned lower reaches of Little Joe, Twelvemile, Twin, Savenac, Big, Packer and Silver Creeks. Ward Creek and Deer Creek, which are almost entirely on National Forest lands, were assessed as possible reference conditions.

The bankfull channel width, distance from Interstate 90, and the percent of each subreach containing at least 100 feet of riparian buffer were measured using an engineering scale and the mirror stereoscope with the 2000 aerial photographs. The 100 foot buffer distance was chosen as a measure of the amount of anthropogenic impacts to the riparian zone and the stream channel. The percent of each subreach with 100 feet of buffer was averaged for both sides of the river.

Land ownership was determined using the NRIS Stewardship Map. Land ownership was described as Forest Service land (fs), private lands (pl), or Plum Creek timber lands (pc). Valley type was determined from USFS data employing the Rosgen classification system (Rosgen 1996). In addition, stream order along the St. Regis River was determined using USGS 7.5 minute series topographic maps (Scale 1:24,000).

Weighted averages based on the length of each subreach in comparison to the overall reach were calculated. Thus, the results of the subreach assessment were summarized as overall reach averages.

Results and Discussion

Land ownership analysis using the NRIS Stewardship map as a reference indicates that 14.9 miles (37%) of the St. Regis River corridor are privately owned, while 25 miles (63%) are located within the Lolo National Forest. Applying a 0.5-mile buffer along the St. Regis River upon the NRIS Stewardship map indicates that the Lolo National Forest occupies 71% of the area, 24% is privately owned, Plum Creek Timber owns 3%, while state trust lands occupy the remaining 2%. There are 18.3 miles of stream with a –45 degree aspect, 15.9 miles with a 90 degree aspect, 3.6 miles with a 0 degree aspect, and 2.1 miles with a 45 degree aspect. Thus, the majority of the St. Regis River flows from northwest to southeast and west to east. Three valley types are present along the St. Regis River. The mainstem of the St. Regis River alternates between Type 2 valleys and Type 8 valleys, while the headwater reaches are found in Type 5 valleys (Rosgen 1996). The St. Regis River is a 5th order stream for 25.9 miles from the mouth upstream to the confluence with Packer Creek. From Packer Creek upstream to Randolph Creek, the St. Regis River is a 4th order stream for 9.3 miles. From Randolph Creek upstream to Brimstone Creek the St. Regis River is a 3rd order stream for 1.1 miles. Upstream of Brimstone Creek the St. Regis River is a 2nd order stream, except for the 1st order tributaries flowing out of the lakes at the headwaters.

Mean bankfull width at the subreach scale varies from approximately 90 feet in Reach 1 to less than 5 feet in the headwaters. Bankfull width is generally correlated with valley type along the St. Regis River. Wider Type 8 valleys have greater floodplain development and higher bankfull widths than the more constricted Type 2 valleys (**Table F-1**). However, channelization is also greater in the narrow Type 2 valleys and may play a role in reduced bankfull widths.

Table F-1. Reach scale comparison of mean canopy density along the left bank, right bank, and overall stream length

Reach	Density Left Bank	Density Right Bank	Density Overall	% Reach with 100-foot Buffer	Bankfull Width (Feet)	Valley Type
1	25	40	35	45	90	8
2	30	45	40	5	55	2
3	20	30	25	20	55	2
4	35	50	45	85	80	8
5	25	40	35	65	90	8
6	35	55	45	45	45	2
7	25	40	35	35	30	2
8	25	75	50	60	20	2
9	40	60	50	75	10	5
10	60	70	65	100	5	5
<i>Overall</i>	<i>30</i>	<i>50</i>	<i>40</i>	<i>50</i>		

Mean canopy density for the St. Regis River averages 30% along the river left bank and 50% along the river right bank. Thus, the overall mean canopy density along the St. Regis River is 40%. Mean canopy density ranges from 20% to 60% along the left bank and 30% to 75% along the right bank at the reach scale. Overall, mean canopy density within each reach ranges from 25% to 65% (**Table F-1, Figure F- 1**). Individual subreach values are presented in **Table F-2**.

Table F-2. Canopy cover assessment along the St. Regis River (measurements in feet)

Reach	River Station	Length	Aspect	Density Left	Density Right	Density Overall	Distance to I-90	Ownership
1.0	0-2700	2700	90	0	40	20	190	pl
1.1	2700-5600	2900	-45	45	50	48	150	pl
1.2	5600-7200	1600	90	30	50	40	80	pl
1.3	7200-9700	2500	45	20	10	15	300	pl
1.4	9700-12200	2500	-45	25	35	30	250	pl
1.5	12200-1400	1800	45	25	55	40	60	pl
1.6	14000-19200	5200	90	25	40	33	30	fs
1.7	19200-21000	1800	-45	40	55	48	110	fs
1.8	21000-22500	1500	45	15	35	25	30	fs
1.9	22500-23200	700	-45	15	55	35	15	fs
Reach	River Station	Length	Aspect	Density Left	Density Right	Density Overall	Distance to I-90	Ownership
2.0	23200-26200	3000	-45	40	50	45	60	pl
2.1	26200-27000	800	0	0	15	8	20	pl
2.2	27000-32000	5000	90	10	40	25	90	fs
2.3	32000-36500	4500	-45	40	50	45	100	fs
2.4	36500-42500	6000	90	35	50	43	55	fs
Reach	River Station	Length	Aspect	Density Left	Density Right	Density Overall	Distance to I-90	Ownership
3.0	42500-49000	6500	-45	20	40	30	60	fs
3.1	49000-50200	1200	0	20	30	25	50	pl
3.2	50200-51600	1400	90	20	30	25	50	pl
3.3	51600-53200	1600	0	20	20	20	25	fs
3.4	53200-55000	1800	90	20	30	25	55	fs
3.5	55000-57000	2000	-45	20	20	20	70	pl
3.6	57000-58500	1500	0	20	30	25	70	pl
3.7	58500-59500	1000	90	30	30	30	200	fs
3.8	59500-61000	1500	0	20	10	15	95	fs
3.9	61000-62500	1500	-45	20	20	20	500	fs
3.11	62500-64000	1500	0	10	30	20	500	fs
3.12	64000-65500	1500	90	35	45	40	600	fs
3.13	65500-68500	3000	-45	5	35	20	100	fs
Reach	River Station	Length	Aspect	Density Left	Density Right	Density Overall	Distance to I-90	Ownership
4.0	68500-70000	1500	0	0	20	10	60	fs
4.1	70000-72000	2000	-45	35	35	35	190	fs

Table F-2. Canopy cover assessment along the St. Regis River (measurements in feet)

Reach	River Station	Length	Aspect	Density Left	Density Right	Density Overall	Distance to I-90	Ownership
4.2	72000-80500	8500	-45	40	50	45	230	pl
4.3	80500-84000	3500	-45	55	65	60	400	fs
4.4	84000-87000	3000	-45	35	60	48	250	pl
4.5	87000-93000	4500	-45	25	60	43	250	fs
Reach	River Station	Length	Aspect	Density Left	Density Right	Density Overall	Distance to I-90	Ownership
5.0	91500-93900	2400	90	55	75	65	370	fs
5.1	93900-95000	1100	-45	55	45	50	220	fs
5.2	95000-99000	4000	90	5	20	13	50	pl
5.3	99000-105500	6500	-45	10	40	30	160	pl
5.4	105500-10700	1500	0	10	40	30	250	pl
5.5	10700-108500	1500	90	35	55	35	200	pl
5.6	108500-111000	2500	-45	40	30	35	350	pl
5.7	111000-114000	3000	90	40	50	45	230	pc
Reach	River Station	Length	Aspect	Density Left	Density Right	Density Overall	Distance to I-90	Ownership
6.0	114000-118500	4500	90	40	55	48	125	fs
6.1	118500-123000	4500	-45	40	60	50	105	fs
6.2	123000-124500	1500	90	20	50	35	115	fs
6.3	124500-127000	2500	-45	15	30	23	110	fs
6.4	127000-129500	2500	90	55	60	58	210	fs
6.5	129500-134000	4500	90	20	65	43	80	fs
6.6	134000-138500	4500	-45	50	55	52	180	pl
Reach	River Station	Length	Aspect	Density Left	Density Right	Density Overall	Distance to I-90	Ownership
7.0	138500-144000	5500	-45	10	20	15	40	fs
7.1	144000-149000	5000	90	10	15	13	40	fs
7.2	149000-152000	3000	90	35	60	48	120	fs
7.3	152000-154500	2500	90	60	70	65	300	fs
7.4	154500-156000	1500	90	20	70	45	75	fs
7.5	156000-157000	1000	45	55	75	65	375	fs
7.6	157000-159500	2500	-45	20	30	25	170	pl
7.7	159500-160500	1000	90	20	75	48	200	pl
7.8	160500-16200	1600	-45	10	10	10	140	pl
Reach	River Station	Length	Aspect	Density Left	Density Right	Density Overall	Distance to I-90	Ownership

Table F-2. Canopy cover assessment along the St. Regis River (measurements in feet)

Reach	River Station	Length	Aspect	Density Left	Density Right	Density Overall	Distance to I-90	Ownership
8.0	162100-163500	1400	-45	0	75	38	190	pl
8.1	163500-169500	6000	90	20	75	48	150	fs
8.2	169500-172000	2500	-45	45	70	58	100	fs
8.3	172000-175000	3000	0	25	75	50	145	fs
8.4	175000-178500	3500	-45	30	75	53	120	fs
Reach	River Station	Length	Aspect	Density Left	Density Right	Density Overall	Distance to I-90	Ownership
9.0	178500-181000	2500	0	40	65	53	150	fs
9.1	181000-185000	4000	90	10	45	28	20	fs
9.2	185000-186700	1700	-45	50	60	55	195	fs
9.3	186700-193000	6300	-45	60	65	63	450	fs
9.4	193000-196700	3700	90	30	60	45	2000	fs
Reach	River Station	Length	Aspect	Density Left	Density Right	Density Overall	Distance to I-90	Ownership
10.0	196700-202000	5300	90	60	70	65	NA	fs

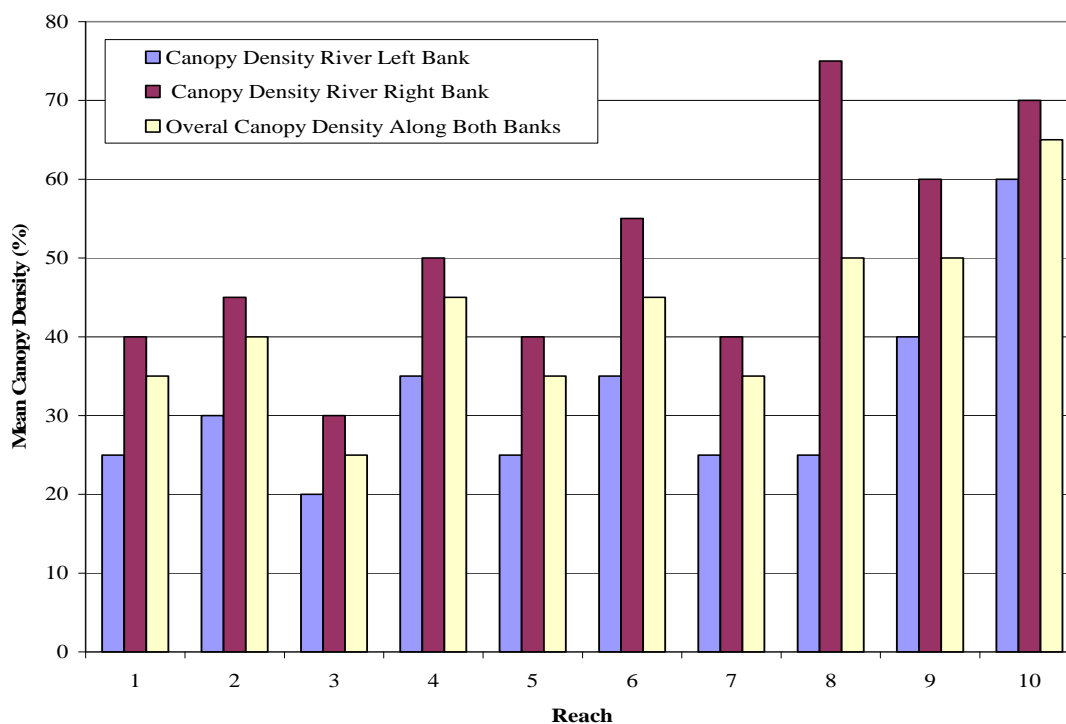


Figure F- 1. Mean canopy densities for the river left bank, river right bank, and overall density for both banks in Reaches 1-9 along the St. Regis River

The riparian corridor along the St. Regis River competes with the transportation corridor for space upon the floodplain. Interstate 90 is primarily situated above the left bank along the north side of the river. The average distance from the stream channel to the interstate shoulder in Reaches 1-9 is 180 feet. Interstate 90 and the old railroad grade, which is located primarily along the right bank on the south side of the river, have effectively reduced the width of the riparian corridor. At least 100 feet of riparian buffer exists along 50% of the St. Regis River (**Table F-1**). The overall length of stream reach with at least 100 feet of riparian buffer varies from 5% in Reach 2 to 85% in Reach 4 (**Table F-1**).

Canopy density at the reach scale varies between the left and right bank. Canopy density ranges from 0-60% along the river left bank. Ten percent of the river left bank has 60% canopy density, 8% has 50% canopy density, 22% of the left bank has 40% canopy density, 11% has 30% canopy density, 26% of the left bank has 20% canopy density, 17% has 10% canopy density, and 6% of the river left bank has 0% canopy cover (**Table F-3**). The close proximity of the interstate has reduced the amount of riparian coverage along the left bank of the St. Regis River. Overall, 40% of the left stream bank has canopy densities greater than 50%, while 60% of the left bank has canopy densities less than 50%.

Table F-3. Percent of left bank containing canopy density expressed in 10% intervals along the St. Regis River

Reach	60%	50%	40%	30%	20%	10%	0%
1	0	0	21	7	52	9	11
2	0	0	39	31	0	26	4
3	0	0	0	10	74	5	11
4	0	15	37	22	20	0	6
5	0	16	24	7	0	36	17
6	0	29	37	0	24	10	0
7	0	4	30	0	15	51	0
8	0	0	15	21	55	0	9
9	35	9	14	20	0	22	0
10	100	0	0	0	0	0	0
Overall	10	8	22	11	26	17	6

Canopy density at the reach scale along the river right bank varies from 10-70%. Nineteen percent of the right bank has 70% canopy density, 17% has 60% canopy density, 22% of the bank has 50% canopy density, 18% has 40% canopy density, 11% of the bank has 30% canopy density, 8% has 20% density, and 5% of the river right bank has 10% canopy density (**Table F-4**). Canopy density is clearly greater along the right side of the river, though the presence of the old railroad grade reduce the shading potential in several locations due to their position in-between the stream bank and the densely forested hillsides. Interstate 90 also impacts canopy density along the right bank in a couple of locations. Overall, 58% of the right bank has greater than 50% canopy density, while 42% of the right bank has less than 50% canopy density.

Canopy cover was field verified at 7 sites in which aerial photo interpretation ranged from 35-75% canopy cover. Canopy cover measurements using a spherical densiometer averaged 10.7% higher than the aerial photo interpretation with the mirror stereoscope indicated.

Table F-4. Percent of right bank containing canopy density expressed in 10% intervals along the St. Regis River

Reach	70%	60%	50%	40%	30%	20%	10%
1	0	0	39	34	17	0	10
2	0	0	70	46	0	0	4
3	0	0	0	31	45	19	5
4	0	48	37	0	9	6	0
5	11	0	20	41	0	28	0
6	0	47	43	0	10	0	0
7	38	0	0	0	11	23	28
8	100	0	0	0	0	0	0
9	0	78	0	22	0	0	0
10	100	0	0	0	0	0	0
Overall	19	17	22	18	11	8	5

Comparison to Forest Service Analysis

Canopy assessments conducted by the Lolo National Forest using satellite imagery data indicate similar results as the aerial stereoscope analysis. Canopy density was assessed along the mainstem of the St. Regis River by the Forest Service for three reaches: mouth to Twelvemile Creek, Twelvemile Creek to Saltese, and Saltese to northwest section 5. In addition, the Forest Service assessed canopy density along Big, Deer, Twelvemile, Ward, and Little Joe Creeks, as well as several upstream tributaries of these creeks. The Forest Service categorized canopy density as high (>70%), medium (40-70%), low (20-40%), and “canopy not mapped” (CNM). The “canopy not mapped” category generally consisted of rock, grassland, and meadow types of coverages that are considered to have a density of 0%. Mean canopy density derived from the Forest Service satellite imagery data and the stereo aerial photography analysis indicates the similarity of the results (**Table F-5**). Thus, Forest Service data will be used for canopy density assessment within St. Regis River tributaries.

Table F-5. Mean canopy density determined by averaging satellite imagery data and stereo aerial photography data

Reach	Source	>70%	40-69%	20-39%	<20% (CNM)
mouth to Twelvemile	satellite imagery	6	39	31	24
Reaches 1, 2, and 3	aerial photographs	0	44	42	14
	<i>mean</i>	3	42	36	19
Twelvemile to Saltese	satellite imagery	7	70	13	10
Reaches 4, 5, and 6	aerial photographs	2	66	21	11
	<i>mean</i>	5	68	17	10
Saltese to nw sec 5	satellite imagery	15	48	16	21
Reaches 7, 8, and 9	aerial photographs	23	35	24	18
	<i>mean</i>	19	42	20	19

Recommended Reference Conditions for Canopy Density for the St. Regis River

Potential restoration sites were selected based on an observed lack of anthropogenic disturbances near the stream channel. These reaches have at least a 100-foot riparian buffer along 100% of the stream channel, except for subreach 8.2, which has at least 100 feet of buffer along 80% of the length. Subreach 8.2 was retained due to its applicability for shrub dominated wetland habitat types in Type 2 valleys. All subreach reference conditions have at least 60% overall canopy density. In-stream changes, such as alterations in sediment load, were not included in this assessment.

Subreaches 4.3 and 5.0 contain reference conditions for Type 8 valleys. Reference conditions in Subreaches 4.3 and 5.0 indicate large deciduous/coniferous floodplain areas have 45-65% canopy density, while coniferous hillsides tend to have canopy densities from 70%-80%. Subreach 4.3 contains a section of National Forest land in which the riparian areas contain a large amount of conifers along both sides of the river. There is 80% canopy density along the hillside above the river right bank and 55% along the floodplain. Floodplain forests along the river left bank are more mature, containing 55-65% coverage with a high proportion of conifers, while

stands of deciduous vegetation are present closer to the channel. Average stream width is 90 feet in Subreach 4.3, with the low flow channel braiding through gravels bars. An appropriate reference reach average based on conditions in Subreach 4.3 would be 60% overall canopy density for Type 8 valleys (**Table F-6**). Subreach 5.0 contains reference conditions on Forest Service land just upstream of the Deer Creek confluence. Reference conditions exist for deciduous/coniferous floodplain conditions (55% canopy density) along river left and the coniferous hillside condition (75% canopy density) along river right for with an overall canopy density of 65% for this Type 8 valley (**Table F-5**). The right side of the river in Subreach 5.0 can be used as the reference condition for reaches where the old railroad grade runs between the channel and the forest.

The reference condition on Forest Service land in Subreach 6.4 has 60% canopy density overall with 55% in the deciduous riparian forests and 65%-70% along the coniferous dominated riparian stands, while dense coniferous forests on the hillside tend to average 75% canopy cover (**Table F-6**). The mean bankfull width along straight reaches is 40 feet, while the meander curves tend to be about twice as wide.

Subreach 7.3 represents reference conditions for Type 2 valleys. Conifer canopy densities range from 65-75% along the right bank, while there is less coverage (55-65%) along the left bank for an overall canopy density of 65% and a bankfull width of 30 feet (**Table F-5**).

Subreach 8.2 provides reference conditions for conifer and shrub dominated wetland habitat types in Type 2 valleys. There is a dense coniferous canopy along the right bank with 65-75% canopy cover at varying distances from the channel with shrubs in-between, while the less dense left bank has 45% conifer canopy density with some deciduous shrubs present. The channel is braided around a shrub complex requiring two bridge crossings at 172,000. Canopy density is 60% overall in Subreach 8.2, while the bankfull width averages from 20 to 25 feet (**Table F-5**).

Subreach 10.0 is a reference headwater condition that may be applicable to tributaries and Type 5 Valleys. There is 55-75% canopy density along this headwater subreach, with greater density along the right bank below the north-facing slope. Overall canopy density averages 65% (**Table F-5**). The stream meanders through a riparian shrub corridor that varies from 20-100 feet wide, while the bankfull width averages 5 feet.

Table F-6. Reference sites

Reach	Station	Length (Feet)	Aspect	Bankfull Width (Feet)	Density Left Bank	Density Right Bank	Density Overall
4.3	80,500-84,000	3,500	-45	90	55	65	60
5.0	91,500-93,900	2,400	90	60	55	75	65
6.4	127,000-129,500	2,500	90	65	55	60	60
7.3	152,000-154,500	2,500	90	30	60	70	65
8.2	169,500-172,000	2,500	-45	25	45	70	60
10.0	196,700-202,000	5,300	90	5	60	70	65

Reference conditions along the St. Regis River indicate overall canopy density at the subreach scale ranges from 60-65% (**Table F-5**), with canopy density along the left bank ranging from 45-60% and canopy density along the right bank ranging from 60-75%. Mean canopy density across the six reference reaches averages 55% along the left bank and 69% along the right bank. An overall canopy density target level of 60-70% is proposed for riparian restoration geared toward increasing shading and reducing stream temperatures along the St. Regis River. However, potential conditions will need to be adjusted based on the proximity of the interstate and the old railroad grade, along with the associated riprap.

Restoration Potential

Based on this aerial assessment, potential sites for restoration were prioritized first by aspect class and then by canopy density. Subreaches with 90-degree and –45-degree aspects (34.2 miles, 86% of the channel length) were selected since these aspects were identified during stereoscope work to provide the most shading. Beneficial shading observed during stereoscope work occurred primarily along the right bank. Thus, all subreaches oriented at these two aspects with 40% or less canopy density along the river right bank were selected. This revealed 64,700 feet (12.2 miles, 31% of the channel length) of right bank along the St. Regis River oriented at 90-degree and –45-degree aspects currently possess 40% or less canopy density. Subreaches containing 20% or less canopy cover along the right bank were then selected within these two aspect classes, which narrowed the length to 19,700 feet. Subreaches 3.5, 3.9, 7.0, and 7.6 are at a –45-degree aspect and have 10-20% canopy density along both banks (**Table F-6**). Sites 3.5 and 7.6 are on private land, while sites 3.9 and 7.0 are on public land. These sites comprise 10,700 feet of stream channel or 21,400 feet of stream bank. Potential restoration projects could focus on increasing the canopy cover from 10-20% to 60-70% for the four separate reaches along 10,700 feet of the river right bank. Subreaches 5.2 and 7.1 are at the 90-degree aspect and have 5-20% canopy coverage along both banks (**Table F-7**). Subreach 5.2 is on private land, while Subreach 7.1 is on public land. These two subreaches cover 9,000 feet of channel of 18,000 feet of stream bank. Restoration efforts could increase canopy cover along the right bank of these sites by 50% overall.

The St. Regis River is a 5th order stream in Reaches 3 and 5 and a 4th order stream in Reach 7. Riparian shade generally has a moderate influence on stream temperature in 4th order streams and a low influence on stream temperature in 5th order streams (Poole and Berman 2001). Thus, restoration sites in Reach 7 may be assigned a higher priority. Subreaches 7.0, 7.1, and 7.6 cover a total stream length of 12,100 feet. A 50% increase from 10-20% canopy density to 60-70% canopy cover along the right bank in these three subreaches would restore thermal protection to 6% of the St. Regis River. Restoration of canopy densities to 60-70% coverage along the right bank within all six selected subreaches totaling 19,700 feet would increase thermal protection along 10% of the St. Regis River.

Table F-7. Potential restoration sites identified using the criteria of -45 or 90-degree aspect and 20% or less canopy density along the right bank

Reach	Station	Length (Feet)	Aspect	Bankfull Width (Feet)	Density Left Bank	Density Right Bank	Density Overall
3.5	55,000-57,000	2,000	-45	50	20	20	20
3.9	61,000-62,500	1,500	-45	45	20	20	20
5.2	95,000-99,000	4,000	90	85	5	20	15
7.0	138,500-144,000	5,500	-45	30	10	20	15
7.1	144,000-149,000	5,000	90	25	10	15	15
7.6	160,500-162,100	1,700	-45	20	10	10	10

Analysis of reach scale canopy densities reveals that Reach 3 has the lowest canopy density, with only 25% canopy density overall and 30% along the right bank (**Table F-1**). Reaches 1, 5, and 7 have 40% canopy density along the right bank, Reach 2 has 45% canopy density along the right bank, while the other reaches have at least 50% canopy density along the right bank (**Table F-1**). To obtain 60-70% canopy density along the right bank in all the reaches riparian coverage should be increased by 40% in Reach 3, 30% in Reaches 1, 5, and 7, and 20% in Reach 2. Possible restoration sites in Reaches 3, 5, and 7 are described in **Table F-7**. Unfortunately, all 6 subreaches identified using the given criteria are confined by riprap to some degree, which may make restoration difficult. Poole and Berman (2001) caution that placing shade trees along channelized reaches only adds permanence to the degraded condition. Identification of a portion of the floodplain where channelization may be removed and floodplain connectivity reestablished, followed by the reestablishment of riparian vegetation, may provide the best long-term restoration (Poole and Berman 2001).

Reach 5 contains a large moderately unconfined floodplain area located on private property that may be an excellent location for stream channel restoration. The overall channel is flowing from the northwest to the southeast in this reach. Upstream of the Big Creek Road bridge the channel is extremely wide, with the bankfull width averaging 200 feet. The large bankfull width allows for greater solar input and may lead to increased stream temperatures. Based on reference conditions in subreach 6.4 the bankfull width should average 65 feet. Riparian vegetation along the left bank is converting to coniferous vegetation, which indicates that the floodplain is not receiving floodwaters. Restoration could address 8,300 feet of channel (1.6 miles) from Big Creek Road bridge at 103,200 upstream to the washed out old railroad crossing at 111,500. The channel could be narrower with more meanders for 3,700 feet from 104,800 to 108,500 along which vegetated areas have a canopy density of 35-55% on the river left bank (except where the road abuts the channel), while canopy density along the right bank ranges from 10-45%. In addition, canopy density could be increased along the right bank, which is currently lined with railroad riprap for 1,300 feet from 108,500-109,800 (**Table F-6**). Thus, restoration efforts along 1.6 miles of the St. Regis River geared towards reducing channel width and increasing the amount of riparian vegetation could lead to lower stream temperatures.

Reach 7 upstream of the Rainy Creek confluence contains approximately 2,000 feet of duplicate roads confining the St. Regis River. The left bank is lined with riprap that protects the more northerly road downstream of the FR 506 bridge. A portion of the more southerly road could be

removed along with the bridge/culvert (at 160,700) and the confluence with Rainy Creek could be improved.

Canopy Density along the Lower Reaches of St. Regis River Tributaries

Lower Little Joe Creek for approximately 0.6 miles contains a wide riparian wetland complex in which deciduous trees along both sides of the river have a canopy density of 35% and the meandering channel has a bankfull width of 60 feet. The valley narrows and the road draws closer to the channel for approximately 0.6 miles further upstream. The canopy becomes denser, with 55% along river left and 65% along river right (**Table F-9**). There is a large private field along river right, though there is a buffer between the field and the stream channel. National Forest land extends upstream to the confluence of the North Fork and the South Fork along which the vegetation becomes dominated by conifers packed closely along the channel with 65-75% canopy density.

Ward Creek is located on National Forest land. The lower 0.7 miles of Ward Creek have a canopy density of 65% along the right bank below a southeast facing hill slope and 75% along the left bank below a northwest facing hill slope (**Table F-9**).

Twelvemile Creek flows for 0.4 miles from the interstate through a wet meadow area upstream toward the road where it becomes channelized for 0.5 miles. There is 15% canopy density in the wet meadow along river left and 45-65% canopy density along river right. The channelized section has a road along the right bank with 0% canopy density and a steep hill along river left that has 75% canopy density. The bankfull width in this reach is approximately 20 feet. Timber harvest along the left bank hillside starts in the channelized reach and extends upstream with an average buffer of 60 feet. Upstream of the channelized reach the corridor between the road and the hillside widens to an average of 250 feet for another 0.5 miles before the river veers to the west and goes under a bridge. The open riparian area has canopy density of 10% while the harvested hillside was assigned a density of 45% to account for the buffer. The river meanders through a valley with several residences for 0.3 miles before going under another bridge and onto public land. There is a stand on either side of the river with 55% canopy density while the rest of the area is relatively open for a reach average of 30% (**Table F-9**).

The confluence of East and West Twin Creeks occurs 0.2 miles upstream from the culvert entrance where Twin Creek flows under the road and then the interstate for 350 feet. There is a tilled field directly abutting the stream channel extending 150 feet up the West Fork upstream of the confluence and 250 feet below the confluence along the mainstem. Other residential and agricultural developments are evident, though the stream appears to be buffered. Canopy density averages 30% along lower Twin Creek (**Table F-9**).

The lower 1-mile of Deer Creek has dense canopy cover along both sides of the stream. The lower 0.4 miles of this reach contain a meandering stream through braided gravel bars with a bankfull channel averaging 40 feet wide, while the upper 0.6 miles is more constricted with shrubs along a much narrower channel. Canopy density along the overall reach is 65-75% (**Table F-9**).

The lower 0.6 miles of Savenac Creek flows through a wetland complex that is confined between the interstate and the hill slope to a width varying from 20 feet to 350 feet. There is a large eroding slope feeding into this wet area. Hill slope canopy density along the left side of the river is 55%, while there is no coverage beside the road along the right side of the river. Upstream, the creek runs for 0.2 miles through a small developed area that includes a bridge. Large conifers with 65% density surround both sides of the stream (**Table F-9**).

The lower 0.2 miles of Big Creek has several residences and a canopy density of 20% along both banks. The bankfull channel averages 90 feet wide while the wetted width is only 15 feet wide in the aerial photographs from 2000. The next 0.4 miles upstream to the bridge appear more natural. The canopy density averages 45% along the left bank and 50% along the right bank (**Table F-9**). Canopy density remains the same on National Forest lands upstream, though the riparian floodplain through which the channel meanders is comprised of dense shrub vegetation and the bankfull width is reduced to 60 feet.

The lower 900 feet of Silver Creek are completely channelized, though there is vegetation along both sides. There is rural residential development along the lower 0.4 miles of Silver Creek that has 55% canopy coverage provided by large deciduous trees (**Table F-9**). National Forest lands upstream are in a relatively undisturbed condition with 75% canopy coverage on the hillsides and shrubs with widely dispersed conifers along the narrow valley bottom.

The lower 0.2 miles of Packer Creek flow through a rural residential area in Saltese where canopy coverage averages 55%. Upstream of the bridge for 0.7 miles to the confluence of the forks is a riparian meadow with an extensive shrub understory and large conifer trees having 50-60% canopy density. There is rural residential development upstream of the forks, though the shrub dominated riparian appears to be largely intact (**Table F-9**).

Table F-9. Canopy density along privately owned tributary reaches as well as Ward Creek and Deer Creek

Tributary	Length (Miles)	Density Left Bank	Density Right Bank	Density Overall
Little Joe Creek	0.6	35	35	35
	0.6	55	65	60
Ward Creek	0.7	65	75	70
Twelvemile Creek	0.4	15	60	40
	0.5	0	75	40
	0.5	10	45	30
	0.3	30	30	30
Twin Creek	0.2	30	30	30
Deer Creek	0.4	65	65	65
	0.6	75	75	75
Big Creek	0.2	25	25	25
	0.4	45	50	50
Savenac Creek	0.6	55	0	30
	0.2	65	65	65
Silver Creek	0.4	55	55	55
Packer Creek	0.2	55	55	55
	0.7	50	60	55

Literature Cited

HDR. 2002. Final Report: Water Temperature of the Lochsa River and Selected Tributaries. Prepared for: Idaho Department of Environmental Quality. Prepared by: HDR Engineering, Boise, Idaho.

Hostetler, S.W. 1991. Analysis and modeling of long-term stream temperatures on the Steamboat Creek Basin, Oregon: implications for land use and fish habitat. *Water Resources Bulletin* 27(4):637-647.

Poole, G.C., and C.H. Berman. 2001. An ecological perspective on in-stream temperature: natural heat dynamics and mechanisms of human-caused thermal degradation. *Environmental Management* 27(6):787-802.

Rosgen, D. 1996 Applied River Morphology. Wildland Hydrology, Pagosa Springs, Colorado.